

Analysis of Roller Unit Assembly of Calcination Drum

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Abstract— Solid waste management is posing a great problem as the population is increasing day by day. The municipal sewage waste has to be disposed properly otherwise it will lead to air pollution and cause the serious effects on the health of human beings. The most common practice adopted is generating methane from municipal solid waste. For this purpose it is necessary that the municipal solid waste which is sent for further processing should be in the form of homogenous mass. In order to form the homogenous mass it is necessary that it should be separated in degradable and non degradable. This degradable waste is then converted into fine particles. To achieve this task the engineers have designed a special instrument named Calcination Drum. Usually Calcination Drum is also known as Rotary Kilns. In primary stage when the Calcination Drum was implemented it was found that some problems were encountered. The main aim of this project is to solve the problems related to guide ring and support roller shaft of Calcination Drum.

The shaft is redesigned by changing its material and considering all forces acting on it. Similarly the modified fabrication process is also suggested for guide ring. In this paper Analysis of roller shaft, roller and Calcination drum is carried out and the stress and deformation is found out in static and dynamic condition. For theoretical calculations of shaft the standard data is taken from design data book and for guide ring Hertz contact stress theory is used.

Keywords— Calcination Drum, Support Roller Shaft, Guide ring, Roller, ANSYS software

I. INTRODUCTION

Solid waste management is becoming matter of great concern due to increasing population. Generally in most cities one common method is adopted for waste disposal i.e. dumping on the grounds present outside the cities. If the non degradable wastes are not dumped properly then it may cause the severe effects like air pollution, diseases etc; considering all these ill effects it is necessary that the wastes should be dumped properly after segregation (degradable and non degradable). Hence engineers developed one drum named Calcination Drum. In primary

stages it was tested and it was found that it encountered some problems as follows:

1. Failure of support roller unit assembly.
 - a) Failure of support roller shaft.
 - b) Failure of support roller shaft bearing.
2. Failure of support roller guide ring assembly.
 - a) Failure of guide ring.
 - b) Failure of guide packing's and ovality with center axis.
 - c) Cracks are developed on the support guide ring.
 - d) Uneven thickness observed on the support guide ring.
3. Failure of welding joints
 - a) Failure in alignment:-
 - b) Alignment of calcinations drum and support structure assembly is mismatched due to wear between the guide ring and roller
4. Calcination Drum Body problems:-
 - a) Because of uneven concentration of sewage waste weight in the drum, there are some difficulties found to maintain the concentricity with structure axis.
 - b) Thickness of plate selected to fabricate the Calcination drum is needed to be redesigned and analyzed.
5. Misalignments of Calcination drum with support structure.
6. Design problems involved with gear drive
 - a) Cracks developed on the gear ring.
 - b) Same problems are involved which are encountered by support guide ring.

II. DESIGN OF SUPPORT ROLLER SHAFT

In this paper we have focused on solving first two problems as mentioned in problem definition. Firstly design of shaft is carried out by considering all the forces acting on it.

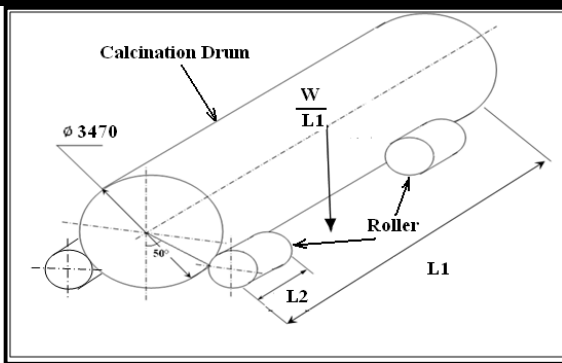


Fig.1: Schematic Diagram of Calcination Drum

The diagram shows the schematic view of Calcination drum where

W = Dynamic Load of Municipal sewage=160 tones

L_1 = Length of Calcination drum =10.4 m

L_2 = Length of Roller =0.35 m

Fig shows the schematic diagram of Calcination Drum. The dynamic load is assumed to be uniformly distributed across the length of drum i.e. (W/L_1). This load will be acting on 4 rollers at angle of 50° and will be uniformly distributed among 4 rollers and after that following the standard procedure the diameter of shaft is calculated.

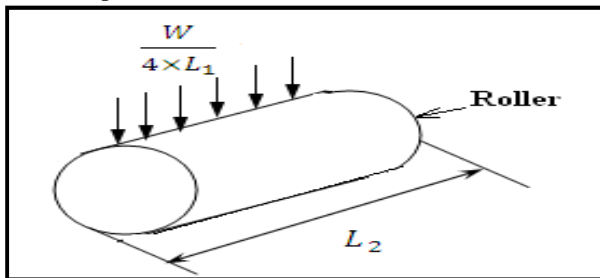


Fig.2: Load Distribution on Roller

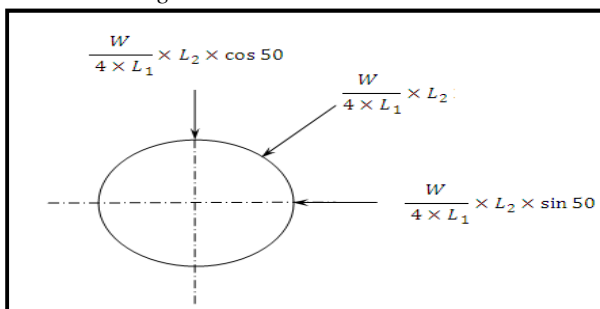


Fig.3: Forces acting on support roller shaft

First of all we are considering forces in vertical plane. The shear force and bending moment diagram is as follows:

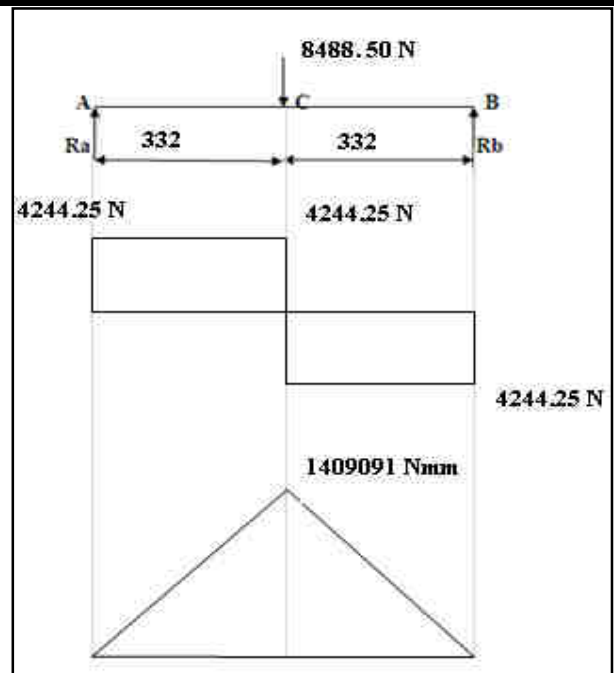


Fig.4: Shear force and bending moment diagram for vertical plane

The maximum bending moment was found to be 1409091 Nmm.

For horizontal plane the shear force and bending moment diagram is as follows

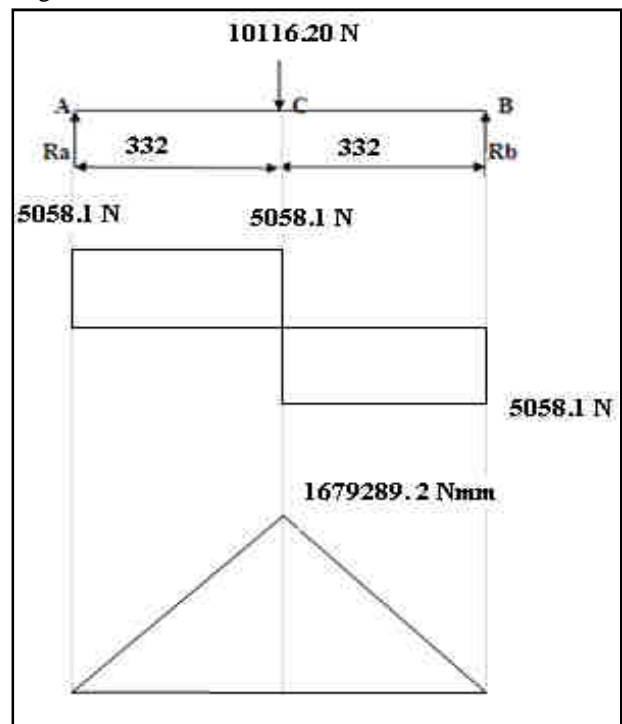


Fig.5: Shear force and bending moment diagram for horizontal plane

The maximum bending moment is calculated as

$$BM_C = \sqrt{(1409091)^2 + (1679289.2)^2}$$

$$M_B = 2192156 \text{ Nmm}$$

$$d^3 = \frac{2192156 \times 32}{\pi \times 145}$$

$$d = 53.60 \text{ mm} \approx 56 \text{ mm}$$

Here by considering the extra jerk and by thumb rule we are going to take the diameter as 130 mm. The material selected for shaft is EN 24.

Based on the diameter we have selected the spherical roller bearing from SKF catalogue. It is expected that the bearing should function properly for 5 years i.e. 43800 hrs. Hence by considering the load acting on bearing We have selected the bearing having the designation 23026 CCK/W33. The selected bearing satisfies our requirement.

III. ANALYSIS RESULTS FOR SHAFT

For the analysis of shaft we have considered the element solid 185.



Fig.6: Geometry considered for analysis

Material properties for Shaft

Sr No	Particulars	Values
1	Young's Modulus	$2.1 \times 10^5 \text{ MPa}$
2	Poisson's ratio	0.3
3	Density	$7.85 \times 10^{-6} \text{ kg/mm}^3$
4	Yield strength	700 MPa

Assumptions & Recommendations for analysis:

- 1) For Shaft with Roller Dynamic FEA Case Torque is applied on Shaft & not on Roller. If we apply torque on Roller beyond certain limit our interference between shaft & roller is not sufficient enough to transmit it from Roller to shaft due to slide & higher Torque Value. Due to this limitation we are not getting realistic behavior that why Torque is applied on Shaft.
- 2) If we trying to capture behavior we need to apply Torque on Shaft which is not in-line with actual mechanics of problem (i.e. Torque applied on Roller).

- 3) Please consider result of Static case only from this report as Dynamic condition is not in-line with actual mechanics of problem.
- 4) So, it is recommended that to refer result from earlier (Shaft Analysis) report for further use.
- 5) To get clear scenario it's better to simulate Full model which will be in-line with actual mechanics of problem.

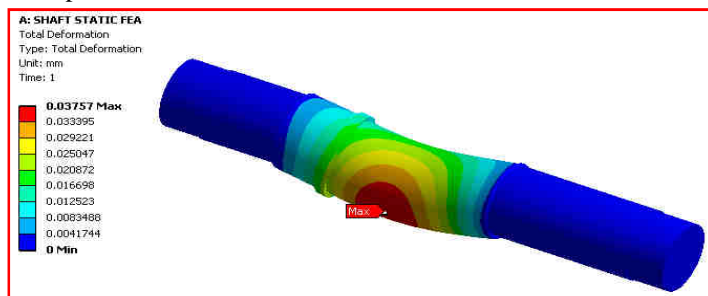


Fig.7: Total Deformation of Shaft in Static Condition

Red zone shows the prime area where deformation occurs most. Value of total deformation decreases as it moves away from the maximum point of deformation and it is denoted by color patterns of deformation plot. . Deformation is occurring near central portion on which roller is mounted. Different color profile represents different value of deformation; these values are mentioned beside the deformation picture. As color profile changes from red to blue the value of total deformation decreases. Value of deformation obtained by FEA analysis of shaft is 0.03757mm

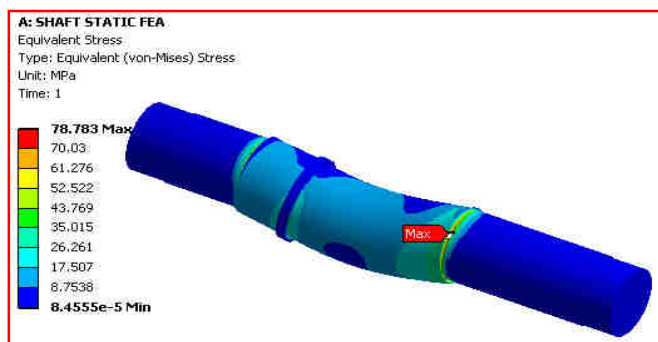


Fig.8: Von Mises Stress in Shaft

From Fig 8 it is found that maximum stress is 78.783 MPa.

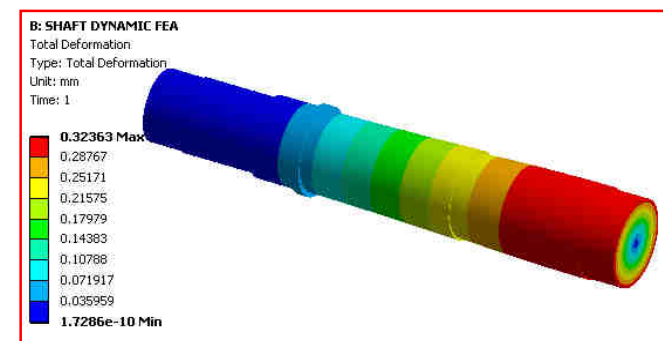


Fig.9: Total Deformation of Shaft in Dynamic Condition

The fig 9 shows the analysis of shaft in dynamic condition. The shaft is in rotating condition. The deformation was observed to be 0.32363 mm.

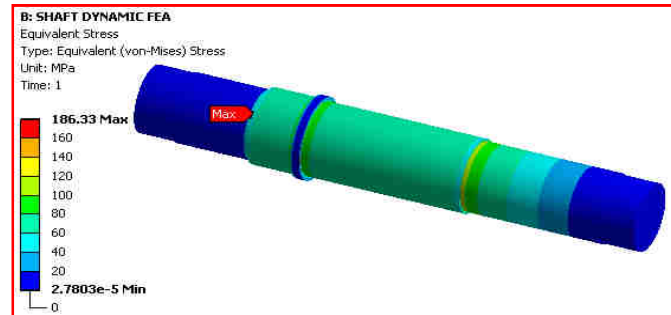


Fig.10: Von Mises Stress in Shaft under Dynamic Condition

The maximum stress was found to be 186.33 MPa. The stress concentration takes place at the place at region at which abrupt change in cross section takes place. The stresses in different regions are shown with different colors.

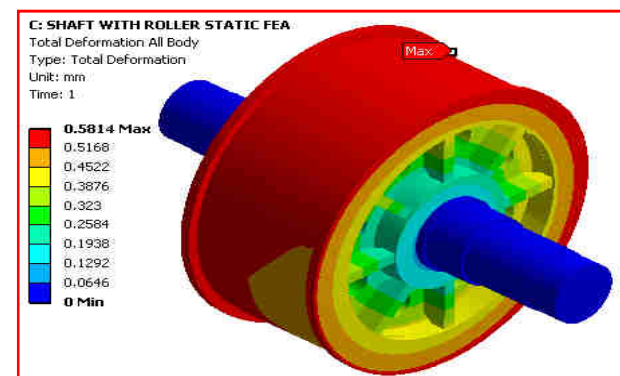


Fig.11: Total Deformation in Roller in Static condition

The total deformation found was 0.5814 mm. The red zone shows the area of maximum deformation. The deformation goes on decreasing as we go radially inwards.

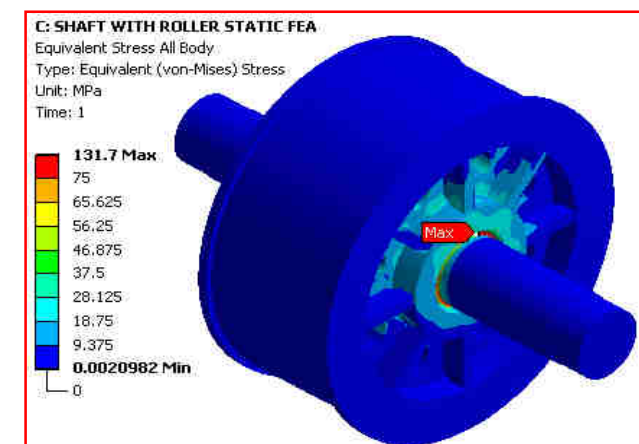


Fig.12: Von Mises Stress in all body under static condition

D: SHAFT WITH ROLLER DYNAMIC FEA

Total Deformation All Body
Type: Total Deformation
Unit: mm
Time: 1

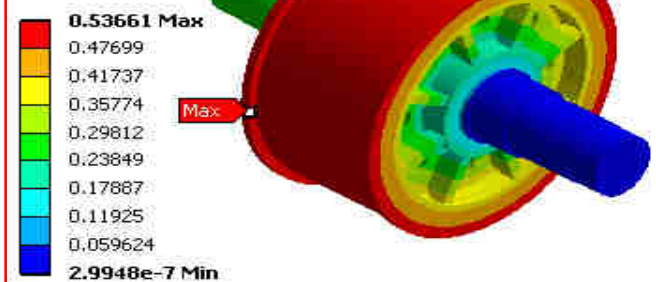


Fig.13: Total Deformation of all body in dynamic condition

Total deformation found was 0.53661 mm in the dynamic condition.

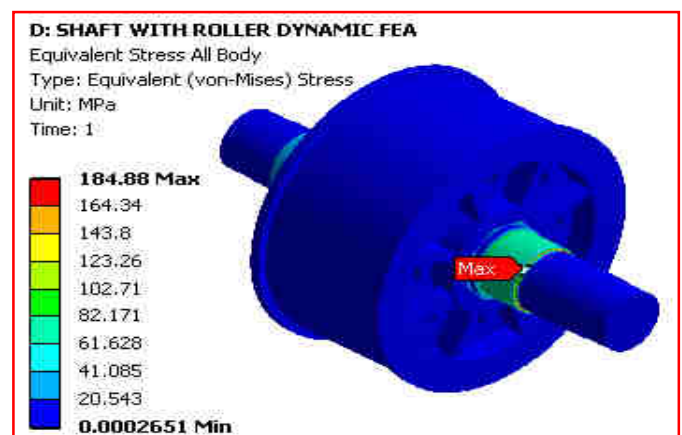


Fig.14: Von Mises Stress in body under dynamic condition

IV. CONCLUSIONS

1. Maximum Deformation in the model are found to be 0.5814 mm.
2. Maximum Stress in the Shaft are found to be 184.88 Mpa which is less than the Yield Strength of Material hence Design is Safe for given Loading & Boundary Conditions .
3. Based on the analysis performed, results seen are safe in terms of stresses as well as deflection. Since worst loading condition may not be regular, the design is safe. But in real time, in case it may not meet the same if material nonlinearity, Geometry nonlinearity & mismatch of the alignment, wrong loading conditions & many other parameters are involved.

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